



**Barcelona  
Supercomputing  
Center**

*Centro Nacional de Supercomputación*



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# Earth System Modelling: requirements and challenges

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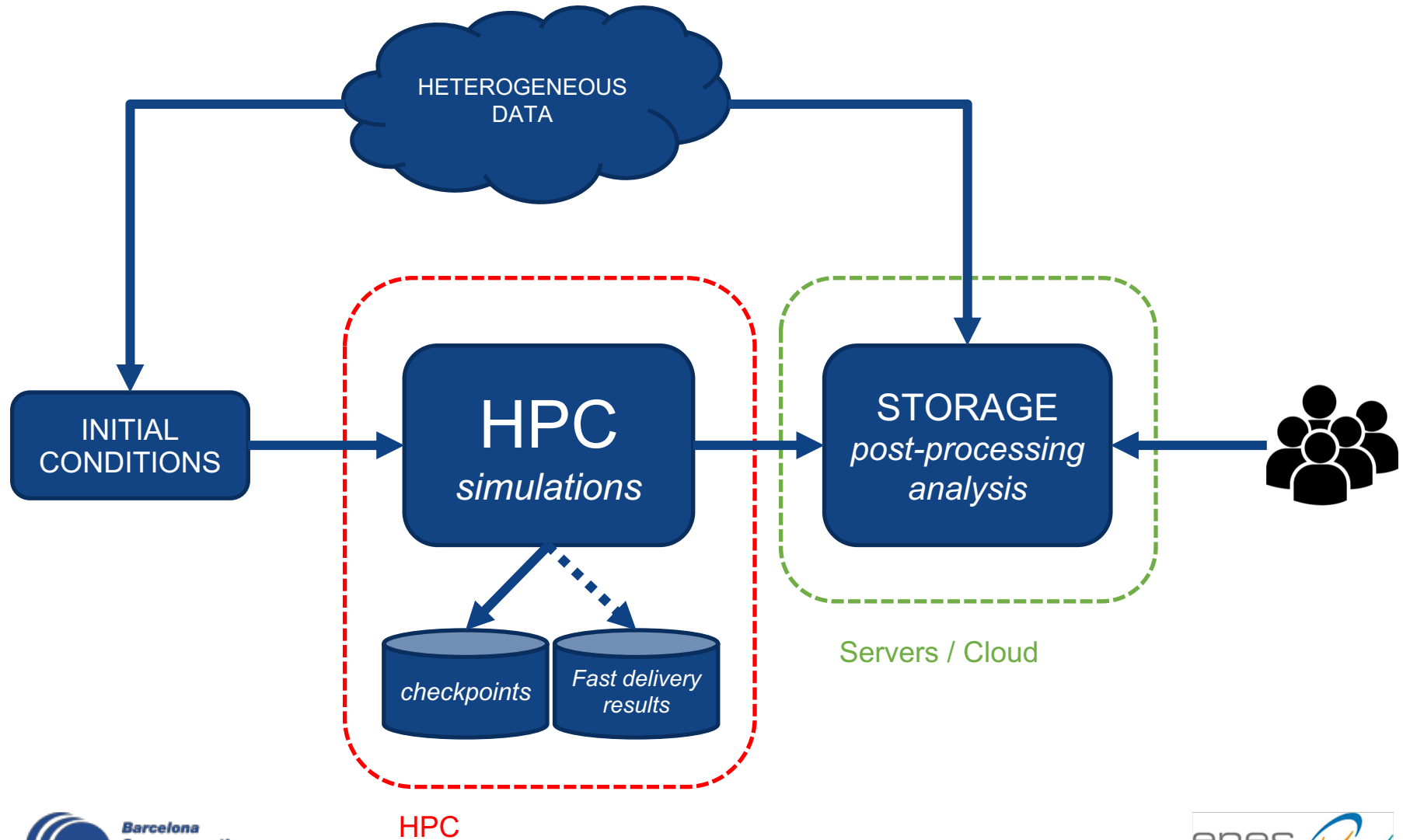
Computational Earth Sciences

19<sup>th</sup>-21<sup>st</sup> February

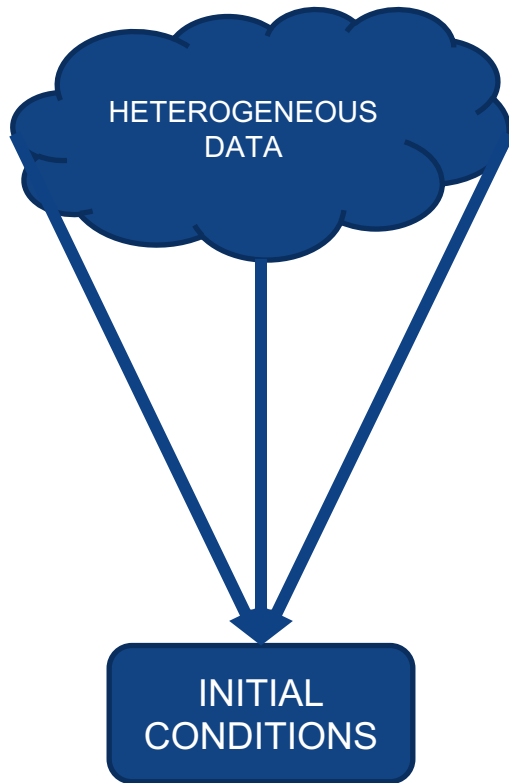
BDEC2 Kobe 2019



# Earth System Modelling Workflow



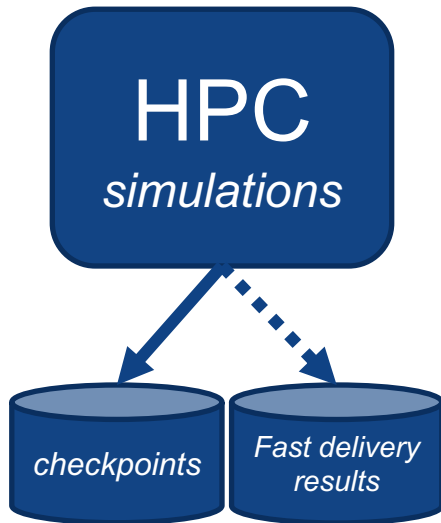
# Pre-processing



- Deal with massive and heterogenous amount of data (Earth Observations)
  - Sensors (with valid and non valid data)
  - Satellite data
- Complex processes to build initial conditions
  - Real-time data
  - Data assimilation
  - Model checkpoints as initial conditions

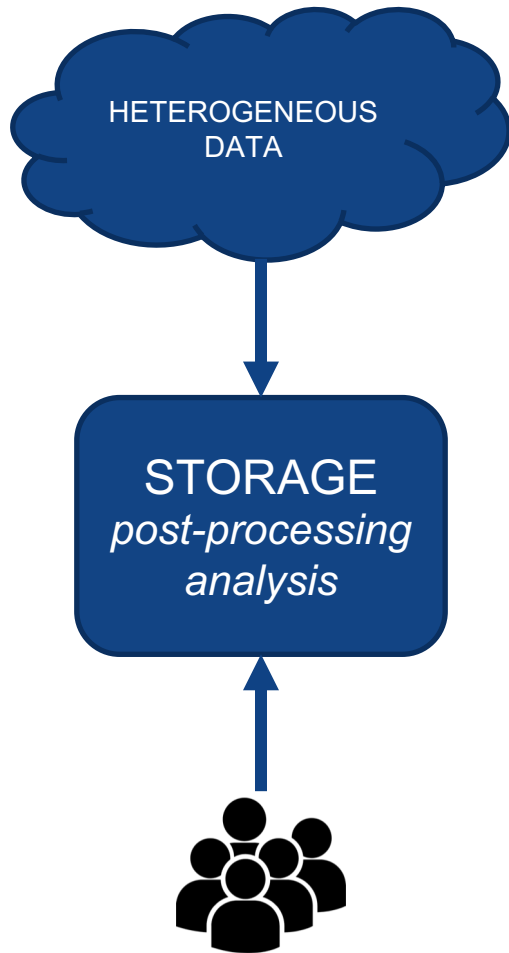
# Model simulation

- Traditional HPC
  - High-powered nodes, large batch jobs, low-latency networks to deal with increasing problem size (resolution, ensembles, ...)
  - Programming models to deal with heterogenous architectures (DSLs and "separation of concerns")
  - Reproducibility
    - Software Stack (using tools like Spack or Containers)
    - Results (CMIP6 exercise → ~ 100 models)
  - Operational services
  - Storage
    - Periodic output of selected variables
    - Fast delivery (for meteorological applications)
    - Traditional (mix disk/tapes) for later analysis





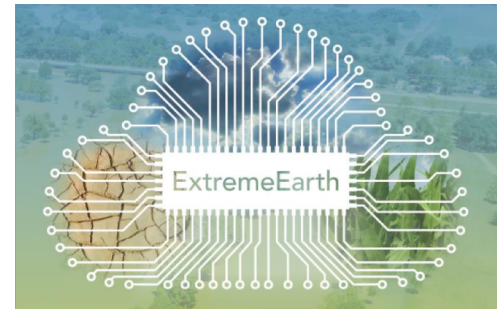
# Post-processing



- Multiple data sources to validate results
- In-situ analysis - visualization
  - Reformatting, sub-setting, re-gridding, averaging...
  - Limit as possible data transfers
  - On user demand analysis and needs
- Reliable dissemination platforms
  - Earth System Grid Federation (CMIP6: 15 to 30 Pb of data)
  - Curated archive, identification and citation
- Efficient and timely handling
- Required throughput for real world applications
- Climate services
- Machine Learning growing need

# And last but not least...

- We need powerful, reproducible and easy to adopt workflows to orchestrate the full earth modelling
- Don't forget "Human factor"
  - One individual, multiples roles
  - Training Research Engineers, Computer Scientists...
  - Identify end-users: Earth Scientists, Data Scientists, Policy Markers...
- Extreme Earth Flagship
  - Technology case (Science Cloud, Big Data handling and Distributed extreme-scale computing)
  - <http://www.extremearth.eu/technology-case>





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# Thank you

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